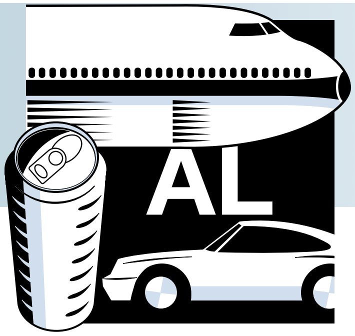
ALUMINUM

Project Fact Sheet



Development of a Novel Non-consumable Anode for Electrowinning Primary Aluminum

Benefits

- CO_2 emissions from the Non-Carbon Anode (NCA) would be one half of those generated by Hall-Héroult Cell carbon anode.
- No objectionable perfluorocarbons or VOC gases are formed, either in the fabrication or in the use of this NCA.
- The carbon plant is eliminated.
- There is an estimated reduction in applied voltage compared to the 4.5V for today's HHC, resulting in reduced electric energy consumption as well as cost savings of about 6 cents per pound of aluminum.

Applications

Successful development of this technology will reduce the cost of producing primary aluminum. This should result in a significant advantage for aluminum in materials selection in automotive and other engineered systems.

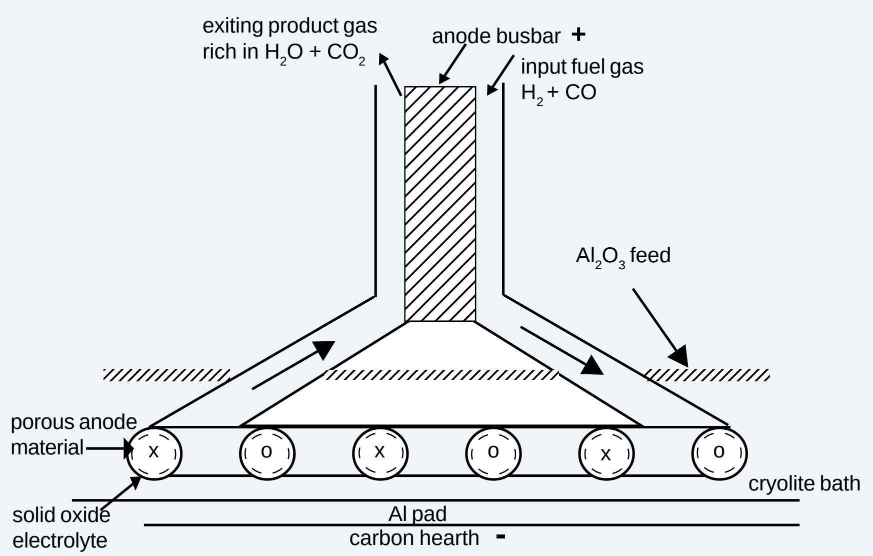
Replaces carbon anode as a retrofit to current Hall Héroult cell

Since the patenting of the Hall-Héroult Cell (HHC) in 1886 for electrowinning aluminum, the basic features have remained essentially the same. Although significant optimization has occurred, industry acknowledges that there are many problems associated with the use of the consumable carbon anode.

A novel non-consumable (gas) anode is proposed which will displace today's carbon anode (eliminating the carbon plant), and serve as a retrofit into the current HHC. The anode is comprised of a thin, dense oxide-ion-conducting membrane with an electrocatalytic porous internal anode where reformed natural gas is electrochemically oxidized.

Application of such a non-consumable anode retrofitted into the HHC would significantly increase the energy efficiency, reduce the emissions, and reduce the cost of producing primary aluminum compared to the best current and emerging anode replacement technologies. This concept could potentially reduce carbon dioxide emissions by at least 50 percent as compared to the current carbon anode, and eliminate other greenhouse gases at the smelting step. Also, the energy requirements and emissions associated with the carbon plant are eliminated. The operation of the new cell requires about one-third less electrical power, further reducing energy requirements.

Tubular SOFC-type Anode



Front view of anode adapted for Hall-Heroult Cell in horizontal orientation. Proposed non-consumable anode could greatly improve energy efficiency and reduce costs of producing primary aluminum.

Project Description

Goals: The goal of this project is to provide the necessary preliminary examination of the chemical, mechanical, fabrication, processing, and economic aspects involved in developing and using the new non-consumable anode. The analyses and measurements will be generally applicable in other aluminum processing areas such as conductivities and alumina solubilities in low-temperature fused salt baths. They also will be applicable in solid oxide fuel cell (SOFC) related development, e.g. optimizing the conductivity in ceria-based electrolytes and the fabrication of an anode-supported tubular SOFC structure.

This project responds to high priority goals in the Aluminum Industry Technology Roadmap and the Inert Anode Roadmap by providing a novel advanced anode technology which is energy efficient, environmentally friendly, and economically advantageous to benefit the aluminum industry, the environment, and U.S. energy security.

Progress and Milestones

Ohio State University:
- Measure the electrical conductivities and alumina solubilities in various low-temperature salt melts.
- Measure the solubilities of potential ceria-base electrolyte components in candidate low-temperature salts. Ceria solute concentrations will be determined by fast-neutron activation analyses at the OSU nuclear reactor.
- Construct and operate a mini-cell to produce aluminum, using as the anode a thick closed-end ceria-base electrolyte tube coated internally with a porous NI-CeO_2 slurry and provided with a reducing gas (hydrogen or natural gas).

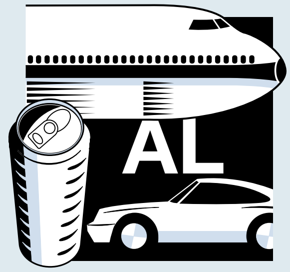
Kaiser Aluminum
- Select promising salt compositions.
- Perform a revised heat balance for the new cell with NCA.
- Participate in evaluation.

Siemens-Westinghouse
- Prepare ceria-base tube with NI-CeO_2 cermet anode.
- Assess alternative fabrication methods.
- Perform electrical diagnostics.

Gas Research Institute / TDA Research
- Evaluate fuel processing options.
- Analyze electrochemical aspects of NCA and aluminum cathode.
- Examine benefits to the aluminum industry.

Commercialization Plan

If the results of the project and associated energy and cost savings prove viable, then follow-on efforts will be pursued to demonstrate and commercialize the retrofitted anode. The next step would be to design and fabricate a pilot-scale anode assembly, and its demonstration in several years.



Project Partners

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Ohio State University
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Siemens-Westinghouse
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